Land Degradation of the Souss River Basin, Morocco

Alexander Schmies

University of Minnesota-Twin Cities

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Abstract

Land Degradation is a critical problem, leading to hunger, poverty, and displacement worldwide. This project aims to contribute to the methodology of analyzing the process of land degradation. Changes in the Normalized Difference Vegetation Index (NDVI) were analyzed in the Souss River Basin, Morocco, from 1999 to 2017 using Landsat 7 imagery. The average NDVI of the entire area of interest increased over the span of the study, which suggests at face value that there was actually an improvement in land quality. However, we have and discuss reasons to believe that this suggestion is not correct and make recommendations for future projects.

Methods

Results from analysis of Landsat 7 NDVI imagery of the Souss River Basin collected from October to January, providing the clearest available imagery for NDVI calculations. spanning the years 1999 and 2017. The average NDVI was calculated based off of a median-pixel composite compiled from October to January in both 1999 and 2017. Next, a linear regression of year versus NDVI for each pixel was mapped over the area of interest for 1999 through 2017. Values from the linear regression and the average NDVI composite were plotted with respect to time. A linear regression line was fitted to the average NDVI plot. Next, the quality of the linear fit was assessed using the R-squared model. Finally, the statistical significance of each of the data sets was verified via the p-value generated from a one-sample t-test.

Average NDVI

Average NDVI based off of a median-pixel composite compiled form October to January in both 1999 and 2017. Color coded images are shown in figures 1 and 2. The NDVI per pixel average over the entire basin is plotted with respect to time in figure 3.

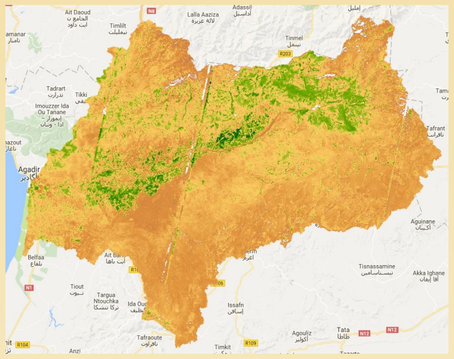

Figure 1: Average NDVI assessed from October, 10th 1999 through January, 1st 2000)

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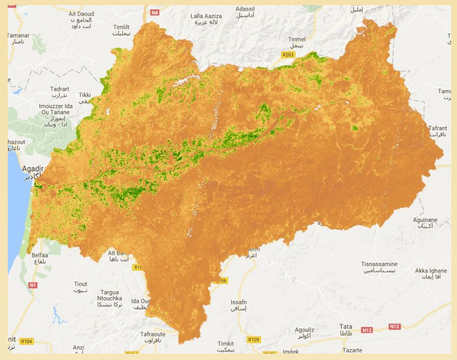

Figure 2: Average NDVI assessed from October, 10th 2016 through January, 1st 2017)

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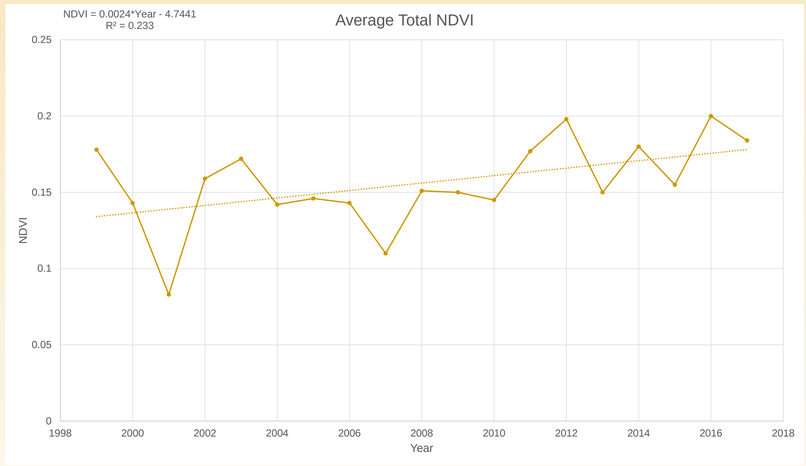

Figure 3: The NDVI value of all pixels within the area of interest were averaged each year and plotted with respect to time.

The slope is positive suggesting an overall increase in NDVI within the Souss River Basin over the course of this study. The p-value of 4.25E-15 suggests the positive slope of 0.0024 is statistically significant. An R-squared value of 0.23 is acceptable considering the variability at work when analyzing the entire river basin.

Linear Regression Map

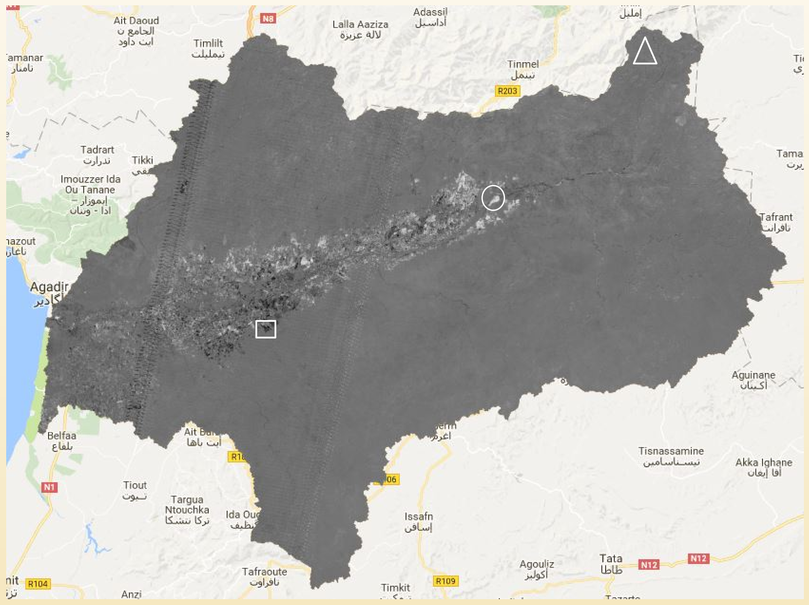

Figure 4: Linear regression of NDVI from January, 1st 1999 to April, 30th 2017 using Landsat 7 Surface Reflectance imagery. Light pixels indicate a positive correlation between NDVI and time, dark pixels represent a negative correlation, and grey pixels represent no correlation.

Linear Regression Analysis of Selected Points

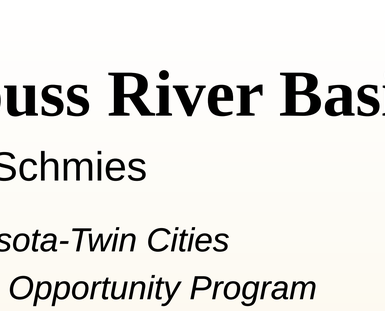

Figure 5: Example of a pixel representing a negative correlation between NDVI and time. Such pixels appear black in figure 4. This pixel is marked with a square.

P-value: 4.37E-7

Figure 6: Example of a pixel representing a positive correlation between NDVI and time. Such pixels appear white in figure 4. This pixel is marked with a circle.

P-value: 9.31E-6

Figure 7: Example of a pixel representing no correlation between NDVI and time. Such pixels appear grey in figure 4. This pixel is marked with a triangle.

P-value: 3.42E-15

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Discussion

Data suggests that the average NDVI of the total area of the Souss basin may have increased slightly over the course of the study. Through analysis of satellite imagery, land use data, and policy documents it was found that the total surface area of protected agriculture via unheated, plastic greenhouses significantly increased over the course of the study, thus limiting the amount of land to be analyzed with satellite data effectively. Therefore, it is recommended that future studies be completed using means not dependent upon remote sensing. Despite increases in protected cultivation, the average NDVI of the entire basin increased. Remote imagery was used to analyze the apparent NDVI of the region. The results of this study find that there are some limitations to the effectiveness of remote sensing in the region, the changes in NDVI can be modeled using a linear regression model, and the average NDVI of the entire river basin has increased over time.

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